THE SCIENTIFIC MONTHLY

JULY, 1918

THE ENGINEERING PROFESSION FIFTY YEARS HENCE II

By Dr. J. A. L. WADDELL, D.Sc., D.E., LL.D.

NEW YORK CITY

IT takes a bold man to endeavor to foretell what changes will occur in engineering during the next fifty years; nevertheless the speaker will make the attempt for the purpose of pointing out a few of the salient possibilities, some of which are easily within reach and should be attained as quickly as possible, while others may, by some engineers, be deemed chimerical. It must be remembered, though, that that highly imaginative French author, Jules Verne, in some of his wildest flights of fancy, was merely foretelling actual occurrences which are to-day so common as to cause no comment.

The speaker has concluded that the most effective way for him to make these various prognostications is by means of an imaginary annual address of the retiring president of the American Academy of Engineers in the year 1968; and he hopes that he will be pardoned for having, when so doing, assumed that the said retiring president is his own grandson and namesake. Such an assumption can certainly do the youngster no harm; but, on the contrary, it may serve him as an incentive to endeavor, should he choose some line of engineering as his life's work.

RETROSPECT

ANNUAL ADDRESS OF

J. A. L. WADDELL, 2d,

Retiring President of the American Academy of Engineers,

Washington, D. C., March 10, 1968

Gentlemen: As retiring president of the American Academy of Engineers in this sixty-eighth year of the twentieth century, at a meeting held specially to celebrate the fiftieth anniversary of the incorporation of the Academy, I have deemed it to be eminently appropriate and fitting to choose as the subject of my address

THE PROGRESS OF THE ENGINEERING PROFESSION DURING THE PAST HALF-CENTURY

In dealing with this subject it has been my aim not only to record the advancement of the engineering profession as a whole, and in detail that of its numerous divisions and subdivisions, but also to indicate the influence which our Academy has had on that development.

As one looks back upon the history of this and other countries since the close of the Great War some forty-eight years ago, he can not help being struck by the immense influence which at every turn engineering has had upon the world's reconstruction and its subsequent development. Almost every step of importance that has been taken was initiated and carried out by engineers; and American technicists in every line have been the ruling spirits in all matters bearing upon the welfare of the nations, taking the lead over the engineers of all the other nationalities, in so far as progress is concerned. The reason for this is that the Great War not only killed off the flower of the European engineers, but also caused most of the European technical schools practically to close their doors, while the United States took the wise precaution of keeping the attendance at such institutions as nearly as possible up to the normal. Of course, the said attendance, immediately after the entrance of our country into the titanic struggle in 1917, was materially decreased by the volunteering into the service of a large proportion of the upper classmen and a smaller proportion of the lower classmen from all of our institutions of learning and especially from the engineering departments of the universities and from the technical and the trade schools; but by the earnest effort of the members of our closely affiliated organization, The Society for the Promotion of Engineering Education, backed by strong pressure from the Administration at Washington, the attendance in the freshman classes of these institutions was at once actually increased a little above normal, and the next year was materially augmented. The result of this wise movement was that as soon as peace was declared and the necessity for world-reconstruction became evident, American

engineers were able to secure not only far more than their *pro rata* share of the work involved, but practically all the important jobs for several years. The hold that they then secured on the engineering work of the world has never since been broken; although, as the European countries commenced to recuperate, their engineers began to get their organizations into better shape, thus reducing somewhat the preponderating influence of the American technicists.

Another reason for that preponderance is that after stupidly doing practically nothing to secure the trade of Latin-America for several years after the war started in Europe, the American bankers, manufacturers and business men finally awoke to the fact that their golden opportunity had arrived, consequently they bestirred themselves and became firmly established in Central and South America, and to a lesser degree in China, before the European manufacturers could get fairly well started again. The smaller success in China was due to the foresight and energy of the Japanese, who established themselves securely in that country while the fighting was still going on. The systematic and combined efforts of American bankers, manufacturers, business men and engineers, applied at the psychological time when nearly all the other peoples of the world were exhausted physically, mentally and financially, resulted ultimately in making the United States the great creditor nation, the American dollar the universal unit of value, and New York City the world's money-center.

In making this retrospect I have been forcibly struck by the greatly increased personal effectiveness of the individual engineer of to-day as compared with that of the individual engineer of the previous half-century. By effectiveness I refer to the extent of the valuable work that a man accomplishes in his entire lifetime. To-day the effectiveness of a high-grade engineer is fully three times as large as it was fifty years ago. For this there have been several causes, among which may be mentioned longevity, education, economics, research, development of a spirit of loyalty, governmental restriction of wasted effort, cessation of war, systematization of technical literature, and increase in number and sizes of technical libraries. I shall take up in the above order and discuss each of these causes.

LONGEVITY

Thanks to the efforts and hard study of biologists, surgeons and physicians, the ordinary limiting life of man has increased from the biblical three score years and ten to a full century.

The studies of the biologists, combined with the coercive work of the Bureau of Sanitation at Washington, have resulted in cutting down nearly to zero the death-roll from all insect-borne diseases, such as typhus fever, malaria, yellow fever, bubonic plague, hookworm, meningitis and mountain fever, as well as other scourges such as smallpox, pellagra, typhoid fever, cholera and leprosy.

The iron hand of the law, combined with a forced enlightenment of the public of all ages and both sexes through the newspapers and the schools, has succeeded in reducing the evil effects of venereal or vice diseases to a very small fraction of their former virulence.

The investigations of the dietetists have taught humanity how best to eat, drink and exercise, not only so as to prolong life but also so as to enjoy it by the possession of good health; and the schools of all grades have taught these doctrines so thoroughly that the unscientific eating and drinking of three or four decades ago is now exceedingly rare. The almost universal adoption of the practise by physicians of giving preventive medicine, instead of trying to overcome disease after it has secured a hold on the patient, has resulted in materially increasing longevity and improving the status of the general health of the community.

The total prohibition of liquor by the federal government in the third decade of the century added, on the average, six years to the life of those men who, otherwise, would have been steady drinkers, besides cutting down crime, profligacy and insanity.

The neutralization of both sexes for crime, insanity, feeblemindedness and bad cases of venereal disease not only has reduced by seventy-five per cent., in a single generation, the number of criminals, lunatics and idiots, but also has had a noticeable effect on the increase in longevity.

While the efforts of certain scientists to prohibit the use of tobacco have proved to be a failure, as far as the populace is concerned, they have succeeded in convincing thinking men that the effect of nicotine on the system is to reduce materially one's mental acumen; consequently a very large percentage of the scientists and engineers of to-day do not use the weed. As a direct result of this there is a small but quite appreciable augmenting of their individual output.

The stamping out of diseases and the increase in longevity have had a double effect upon the improvement of the engineering profession; for not only has each engineer now a greater

number of years than formerly to devote to his work; but also his general health is so much better that he can accomplish much more per hour and can work more hours per day than he did in previous years. It has been noticed, too, that there is a more widespread love for work and mental effort among engineers of all lines and classes than there used to be; and this is very properly attributable to their better general condition of health. Again, if one were to plot the annual effective accomplishment of the average engineer of the present period, it would be seen that the amount continues to increase almost to the time of death, instead of reaching a maximum long before then, as used to be the case half a century ago. By the term "annual effective accomplishment" I do not mean either the number of hours per year that an individual can work or the yearly amount of useful labor that one man can do, but the results that are attained annually through his direction and advice based upon his accumulated experience, and, especially, upon his knowledge of engineering economics.

EDUCATION

During the last fifty years there have been many fundamental improvements in both general and technical education, and these have had much to do with the increased effectiveness of engineers. In the common schools it has been found practicable, without overworking the children, to improve their mentality and increase their knowledge many fold, simply by adopting scientific methods of imparting instruction and by employing a much higher grade of teachers than was customary forty or fifty years ago. In the old days there seemed to be a notion prevalent that if a man or woman were a failure at most things, he or she would do well enough for a teacher, and that there was no need for paying high salaries to instructors. To-day an entirely different view is held, for now teachers as a class are about the best paid people in the community; and their standing therein is second to none.

The most important and fundamental accomplishment in education has been teaching pupils how to think and how, when studying, to concentrate their minds, rather than cramming their memories with a mass of facts, many of which are of doubtful value on account of being subject to change.

The study of vocational fitness of both children and adults which was inaugurated in the early twenties, and which required a full decade to establish as an economic necessity, has done much to improve engineering by preventing the unfit from entering its ranks.

In respect to technical education, thanks to the Society for the Promotion of Engineering Education, it may be stated that the methods governing it have been fundamentally changed. In the old days many insufficiently trained young men, and many who were intellectually and temperamentally unfit, were allowed to enter the technical schools, where during a period of four years they were stuffed with facts *ad nauseam*, with the result that the graduates were not deep thinkers; besides which, they were sadly deficient in those lines of education which were not purely technical. They were, in short, highly trained human machines, capable of earning a living in the employ of some large manufacturing or contracting company, but incompetent either to take their places as worthy citizens, or to originate things of real value by concentrated mental effort.

After many experiments and failures, it was learned that engineering cannot be taught in a four-year course, and that an engineer's education should cover many studies besides those of pure technics. Again, it was learned that it is bad policy to try to train all engineering students for the same ultimate object, because some men will do well as subordinates and others as leaders and originators. The ultimate solution of the problem of technical education was the establishment of three kinds of technical schools, viz., trade-schools for the rank and file, or for those who by their individual limitations are doomed to mediocrity; broad engineering courses for good students, teaching them thoroughly mathematics, the humanities, economics, elementary technics and general culture; and postgraduate schools for the best of the technical graduates, giving elaborate instruction in both the theory and the practise of the various special lines of work. The result is that the profession is now well supplied with capable "hewers of wood and drawers of water"; that there is turned out annually a large number of highly cultured and broad-gauge young men who are drilled in the elements of technics, who are well fitted to begin service in almost any line of activity, and who will be able to advance rapidly therein; and that there is an adequate number of specially trained technicists who can at once successfully fill important positions.

ECONOMICS

Up to the beginning of the third decade of the century, but little attention had been paid by engineers in general or by instructors in engineering to the important subject of "Economics." It is true that the leading American engineers had individually studied deeply into the matter when making their

designs, and that a few of the technical writers (especially in bridge subjects) had touched upon the question; but it was not until 1915, when the Society for the Promotion of Engineering Education appointed a special committee on "The Study of Economics in Technical Schools," that a systematic effort was made to devote due attention in such schools to that fundamentally important feature of engineering. The result of the committee's report, which was presented in 1917, was ultimately the publication under the auspices of that Society of an elaborate treatise on "The Economics of Engineering," written by a large number of specialists in all lines of technical activity. This book served as a basis for the preparation of other works more suited to students' use; and the study of economics in all the technical schools of the country was soon thereafter undertaken in earnest, with the result that to-day all engineering projects are much more economically handled in respect to both design and construction than they used to be. I might mention that in the accomplishment of this great desideratum our Academy cooperated most effectively with the Society for the Promotion of Engineering Education.

Incidentally, it might be stated that the economics of engineers' time and effort have been made the subject of much deep thought, and that important results have been accomplished thereby through time-and-labor-saving devices such as the slide-rule, the pantagraph, the integrating machine and numerous other mechanical computers, through systematization of the individual's work and the avoidance of duplication in investigations, and through the thorough checking of all calculations and plans before work thereunder proceeds.

The compulsory introduction of the metric system of weights and measures about the end of the third decade of the century, while at first proving to be a hardship and an expense to most people, and especially to engineers, eventually became a great time-saver for all computers.

As a side-issue in the matter of economics, I might mention that, over forty years ago, the federal government, as a matter of political economy, undertook the storage of grain and other food products so as to carry over the surplus from the years of plenty to the years of scarcity, and thus to equalize both the earnings of the producer and the general cost of living. Large grain bins and cold-storage plants were built and operated by the government in all parts of the country; and the result of the movement has been eminently satisfactory. Parenthetically, I might state that this step inaugurated a campaign of ex-

termination against rats and mice, which was later extended to include all useless cats and dogs. The economy effected by this campaign amounted to some hundreds of millions of dollars annually; consequently it has been made a permanent institution under federal-government control.

Research

Up to the third decade of the century the work of engineering research was handled mainly in the universities and technical schools, although the Bureau of Standards at Washington had been making many important investigations; but since then the greater part of such research has been done by the federal government through that bureau, and on a much larger scale than formerly. The beneficial effect on the profession of the results of the many researches in all lines of technics is simply incalculable. By its recommendations to the federal government concerning proposed investigations and by suggestions of its own thereto, our academy has rendered most effective service in this line of activity.

Development of a Spirit of Loyalty

Regarding loyalty to the profession, Sir Francis Bacon said:

> I hold every man a debtor to his profession, from which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves, by way of amends, to be a help and ornament thereto.

The development of a spirit of loyalty to our profession has been a slow process, spread over a long period of years; but I am happy to say that to-day it pervades all ranks of engineering and is the mainspring of both individual and concerted action in all matters professional. The instruction of engineers in respect to the necessity for professional loyalty was the work of the various technical societies of the country, which were systematically instigated thereto by the American Academy of Engineers. The members of our organization take great satisfaction in this accomplishment.

Governmental Restriction of Wasted Effort

While it is true that, in the early days of modern engineering, the factor of competition in design and the stimulation to mental effort which it produced had much to do with the advancement of American engineers ahead of their European brethren, it was gradually carried to greater and greater excess until it resulted in being a heavy burden upon the profes-

sion. It became customary among municipalities and the promoters of enterprises to advertise for competitive studies and plans. Sometimes, but by no means always, they would offer a small prize, hardly large enough to cover the cost of a single set of papers, the real bait being the promise of the engineering to the successful competitor. In many cases the project failed to materialize, in others even the payment of the prize was dodged, and it was not an uncommon occurrence to have the total expenditure on studies by the numerous competitors far exceed the net amount of the total fee earned by the successful competitor.

Some forty years ago, the academy took hold of the matter, pointing out the injustice done to the profession, and succeeded in having Congress pass a law making all such competitions illegal, and providing that any person, company, or community desiring competition on engineering or architectural projects or plans must limit the number of competitors, must pay each unsuccessful competitor a fee large enough amply to cover his entire expense in the competition, and that the prize for the successful competitor must be either retention on the work at the standard rate of compensation, or a sum of money at least five times the amount of the expense to which he is put in preparing his competitive papers, the actual amounts of the payments being settled in advance by agreement between the promoter and the various competitors. This law, while cutting out all illegitimate and unnecessary competitions, has not militated materially against the public's receiving, whenever necessary or advisable, the benefit of competitive effort; but it has proved a great boon to the consulting and independent engineers of America. The Canadian Academy of Engineers, which was established in 1923, soon followed our lead in this movement, and succeeded in having similar legislation passed by the Dominion Parliament.

Cessation of War

The sudden cessation of war throughout the world, after the conquering of the Central Powers by the Allies nearly a half-century ago, with the establishment of permanent peace by means of an armed alliance, and with the subsequent gradual reduction of the policing armament which ensued as the nations became accustomed to arbitration and alive to its wonderful advantages, permitted some of the best brains of the world to turn from thoughts of destruction to those of construction; and thus the engineering profession received the benefit of an increased amount of highly skilled labor and inventive genius.

To-day any invention of an instrument of destruction is frowned upon by all thoughtful people; and any one who advocates war in any shape is treated as a public enemy and punished accordingly. As a result of the successful establishment of world peace, Congress in 1937 changed the name of the War Department to that of "Peace Department," and the name of the Navy Department to that of "Navigation Department."

Systematization of Technical Literature

By the suggestion of our academy, the federal government in 1923 undertook to issue annually (and later semi-annually) a pamphlet giving for each engineering specialty a list of the best and most useful technical books published in the English language, and indicating in condensed form their contents. This is kept up to date by the direction of a committee of the academy, all books being dropped from the list as soon as their practical usefulness ceases. The result of this innovation has been to enable both individual engineers and the libraries of schools and municipalities to purchase the treatises they need without squandering their money on works that will be of no practical assistance.

Increase in Size and Number of Technical Libraries

The mass of technical literature has gradually become so large that it is impracticable for most engineers to purchase all the books they need; consequently, at the request of our academy, the federal government has initiated the custom of making allowances to public libraries for the purchase of technical works. It is, therefore, practicable for an engineer located in a city of any size to find all the references he needs in his work without having a large library of his own. This arrangement has been of great service to the profession, especially to its younger members.

Some of the other important items of influence in the general improvement of the status of engineering during the last fifty years are the following: The establishment of the American Institute, the inauguration of the Department of Public Works, the Federal licensing of engineers, the permanent alliance of labor and capital, the formation of the Industrial Army, the reform of the Patent Office, the universal distribution of power by the government, the enforced conservation of materials, the utilization of by-products, the proper restriction of the employment of the term "Engineer," the avoidance of

disasters to great engineering constructions through extra checking of plans, the establishment of a code of engineering ethics, the inauguration of legalized distinctions, the determination of minimum charges for services, the improvement of technical literature, the systematic promotion of projects, the working of American engineers abroad, the installation of concerted publicity movements, and, finally, the due recognition of the profession by the nation. As before, I shall discuss each of these items in the order in which they are mentioned.

American Institute

When the founders of our academy first proposed its formation, they had a still greater step in mind, as was indicated in public on several occasions, viz., the establishment of an American Institute on the lines of *L'Institut de France,* to include besides our own organization the then-existing National Academy of Sciences and all future duly-organized American academies, such as those of Architecture, Medicine, Literature, Law, Journalism, Art, Political Economy and Universal Peace.

During the third decade there were established only three of these academies, making five all told. Then the dream of the founders of our academy came true, for the American Institute was formed in 1927; and within the next five or six years the other academies just mentioned were organized, each one, as soon as established, becoming a member of the institute. This organization holds regular meetings only twice a year; but occasionally it has called a special meeting to discuss and take action upon some burning question of the hour. The fine building for the institute, in which are located the headquarters or offices of all the component academies, was presented by the federal government in 1929 at a cost of about twenty million dollars. The bringing together of engineers and other learned men from the various walks of life to discuss matters of great moment in which their lines cross has done much for humanity; and especially has it benefited the engineers by forcing them out of the narrow ruts into which they constantly tended to fall, and broadening them by contact with many of the most brilliant minds of their compatriots.

A number of special meetings in the Institute House of two and sometimes three academies have been held for the purpose of taking action on questions in which they were jointly interested; and these meetings also have been found eminently productive of good for the commonwealth. Among other benefits obtained in this manner might be mentioned the partial purifica-

tion of politics (it would prove an impossible task to cleanse it thoroughly!), the remodeling of the American diplomatic service so as to make it superior to that of any other nation, and the reform of the Patent Office.

Department of Public Works

The first great task undertaken by our academy was the establishment of a Department of Public Works to take over all the engineering work which had hitherto been distributed rather illogically among several of the departments of the government. It required a hard fight to accomplish this; but the results have proved, beyond the peradventure of a doubt, the importance of the measure. This department is practically removed from politics, because its secretary (always a civil engineer of high standing, undoubted attainments and special fitness) continues to hold his position in spite of changes of administration, retaining it as long as he is mentally and physically fit to attend properly to the work of his high office.

Licensing of Engineers

During the second decade of the century there had been much controversy among engineers concerning the advisability of not permitting technical men to practise without first securing a license. Many were the arguments advanced by both sides, and most of them were sound. Those favoring the movement declared that engineering could never attain to its full measure of public respect without the license system, while those opposed stated that the control of their professional activities by the numerous states would be intolerable. A compromise was finally effected by a general agreement to accept a federal license, based upon broad lines, and to repeal the few state technical-license-laws that had already been put into operation. As you all know, the result was eminently satisfactory. Not one of us would be willing to revert to the non-license days.

I do not believe that any one would dare to contradict me when I claim that the credit for the satisfactory settlement of this long-mooted point belongs to the American Academy of Engineers.

Alliance of Labor and Capital

Up to the year 1929, from time to time there had been struggles of a bitter nature between organized labor and capital, to the great detriment of progress in all lines of business. These

disagreements seriously interfered with the work of engineers by paralyzing the progress of their constructions and by discouraging the investment of money in sound enterprises involving engineering. The conditions finally became so bad that nobody could safely undertake to materialize any large project. It was then that our academy stepped into the breach, and, after several years of continuous effort, succeeded in forming an amalgamation of working men, contractors, manufacturers and bankers which has been the means of absolutely preventing strikes, every incipient dispute now being settled by arbitration. Organized strikes of any kind are to-day treated as "conspiracy" by the laws of the land.

INDUSTRIAL ARMY

Some forty years ago when our standing army was finally reduced to a mere police force, the government recognized that some similar body was necessary in order to provide labor for the unemployed; hence it inaugurated the "Industrial Army," composed mainly of volunteers, but also having some regiments recruited solely from the hobo and the minor-criminal classes. These men are drilled and trained in the lines of peace as formerly were soldiers in the lines of war, so as to make them effective. They are sent out on public works, and their services are occasionally loaned to the large contractors. They are paid monthly and are fed and clothed at government expense. Their services have proved of great value in agriculture; for, owing to their mobility, they are sent from south to north in the harvest season, then shipped south again and gradually moved northward so as to care for the plowing of the land and the cultivating of the crops.

There are separate regiments for the different kinds of work; but in case of necessity, the character of the men's occupation is changed. The enlistment period is four years; and deserters are punished just as drastically as were formerly those from the military army and the navy.

The establishment of this industrial army has proved to be a great boon to the engineering profession, in that there is at all times a certain amount of dependable labor which can be utilized on important constructions. Moreover, it tends to stabilize the price of labor, and thus encourages promoters and contractors to undertake great enterprises.

Patent Office Reform

The reform of the Patent Office was a hard nut to crack, but by working jointly with the American Academy of Law we managed to accomplish it. In former times that office was a standing joke. Anybody could patent almost anything; and conflicting patents were quite common. The government evidently was of the opinion that any one who was not satisfied with the way his patent was recognized by his competitors could secure satisfaction by an appeal to the law; but that process usually proved to be interminable and exceedingly expensive. Engineers considered that a patent was simply a club with which to frighten off intruders—and as such it often proved a failure. Again, it was customary to grant patents for the most minor details of design and for the smallest kinds of improvements, notwithstanding the fact that some eminent jurists declared such patents to be invalid.

To-day all such conditions are changed. Patents are being granted only for those things which are truly innovations; and it is almost unheard of to find one patent conflicting with another. To accomplish this is what the Patent Office officials are paid to do; and no shirking of the responsibility is any longer permitted.

Power Distribution

One of the most fundamental and drastic actions ever instituted by the federal government was the permanent taking over by it of the entire power supply of the United States and making the unit prices thereof the same in all localities, the exact schedule rate to the consumer being dependent to a certain extent on the amount he uses regularly. The results of this innovation were a marvellous economy of energy for the nation, a universal satisfaction on the part of all power users, and an almost automatic adjustment of fairly uniform production throughout the entire year.

All kinds of power are included. All large waterfalls are utilized, even to the total drying up of Niagara Falls, except for two hours on each Sunday afternoon during the months of May to October, inclusive, at which times, as you know, only enough water is allowed to pass over the falls to produce the desired scenic effect.

Coal is now burned mainly at the mouth of the mine instead of being transported long distances at great expense by rail—in fact for a while the experiment was tried of burning it *in* the mine; but this was soon abandoned after several costly conflagrations had occurred.

Natural gas is employed somewhat for power purposes; but generally it is found more satisfactory to pipe it to the cities for domestic use.

Following the lead of an eminent Italian engineer, we have been endeavoring with more or less success to utilize the internal heat of the earth; but there are only a few places in our country which are suitable for this process of power production.

For a long time it was thought that the utilization of tidal energy could not be made a paying enterprise, but in the early thirties a successful plant was built in New Brunswick to harness some of the power of the noted tidal bore. Both ebb and flow were utilized, although not to the same extent. Of course, only a small portion of the energy of the flowing water could be impounded, but there is enough and to spare at that locality. Afterwards, the employment of tidal energy was done on a commercial scale and upon a paying basis at a number of places in the United States; but it is not a very economic way of obtaining power.

The extraction of energy from wave motion, as suggested by Joseph Tomlinson, a noted Canadian engineer, as long ago as 1876, has never proved to be a commercial success, because the cost of the apparatus is too great in comparison with the value of the energy collected. It does pay, however, in the case of small, isolated lighthouses where to convey the required energy from the mainland would be either impracticable or very expensive.

The great improvement that has lately been effected in the efficiency of sun-power motors has enabled us to utilize direct solar energy upon a commercial basis in the states of California, Arizona, New Mexico and Western Texas, also in the Territory of Lower California. The last was purchased from Mexico in 1920 after the cessation of that country's series of continuous revolutions, in order to give it money to pay all legitimate claims for damages to the Mexican properties of American citizens and British subjects, and to enable it to carry on its government during the period of reconstruction.

The products of all the power-producing plants are combined and distributed in the most economic manner practicable, the method varying with the time of year and with the hygrometric conditions of the various districts. The ability of the government to distribute the power throughout the country, economically and as desired, is due mainly to a most important discovery by an American metallurgist of the alloy "electroconite," which, in the form of wire, combines a satisfactory

strength with a resistance of only about one tenth of that of the best previously known conductor.

The credit for establishing the government control of the manufacture and distribution of power is due essentially to the constant and systematic efforts of the American Academy of Engineers.

At one time the wireless transmission of power was seriously considered, and, in truth, it was shown to be a possibility; but when trying it on a commercial basis there developed so many unanticipated obstacles that it was abandoned. Similarly, it was shown to be feasible to produce electric energy directly from coal, but practically it was found more economical to burn it. Greatly improved methods of doing so were discovered, so that to-day there is utilized a far higher percentage of the energy of the coal than was even dreamed of formerly.

CONSERVATION

The conservation of the country's resources for a long time occupied the attention of many prominent, far-sighted and patriotic Americans, who pointed out that eventually the nation would assuredly come to grief, unless it ceased wasting its resources. While their preaching was not altogether without effect, it was not until 1938 (when the joint efforts of the American Academy of Economics and our own organization induced the government to establish a Department of Conservation) that effective measures to curtail waste were established and enforced. The result has been a decided benefit to our profession, in that now we all know what materials can and what can not be used for our constructions, and that the public will not be allowed to bring the commonwealth to poverty and disaster by needless waste.

UTILIZATION OF BY-PRODUCTS

In the beginning of the twentieth century, the study in America of how best to utilize by-products was begun; and it was carried on in a rather desultory manner in the universities and some of the technical schools. The University of Kansas made a rather spectacular start in this line of research, the work being carried out upon a strictly business basis, and achieved quite a success; but soon thereafter, owing to a change in the personnel of the faculty, the endeavor was dropped.

It required the advent of the Great War in Europe to teach Americans that they must make themselves independent of the rest of the world by manufacturing at home all the necessaries

of life for both peace and war. This condition aroused to action our chemists and chemical engineers, and incidentally caused them to study the utilization of by-products, thus materially increasing the wealth of the nation.

Restriction of the Term "Engineer"

It seems almost ridiculous or impossible of belief that the long-continued misuse of a name should seriously militate against the proper appreciation by the public of a great profession; but such certainly was the case. The term "engineer" formerly was applied indiscriminately to locomotive drivers, electric motor men, stationary-engine men, and even to the operators of insignificant gasoline engines, as well as to the members of the engineering profession; and the public was unable to distinguish clearly between the highly trained professional man and the roustabout engine-manipulator. For long years our profession failed to receive due public recognition; and this absurd misconception of terms was one of the principal reasons therefor. The trouble was finally overcome by the concerted action of the leading technical societies, both national and local, the members of which pledged themselves on every occasion to correct, either orally or in writing, every misuse of the term, irrespective of the standing or character of the delinquent. It did not take more than a twelvemonth to establish the change upon a permanent basis.

Avoidance of Disasters by the Extra Checking of Plans

About the end of 1917, after having had the idea in mind for several years, a well-known engineer-author suggested in the technical press that, in order to avoid disasters to great public or private engineering constructions, such as the two which occurred to the famous Quebec Bridge, all the plans for such structures should be thoroughly checked by an engineer or engineers of the highest standing who had not been in any way concerned in the making of the design, the compensation for such checking being paid by the client and not by the designing engineers. Although the scheme met with some opposition at first, it was eventually adopted. The non-occurrence of any great disaster of the kind during the last four or five decades affords ample proof of the wisdom of the precautionary expedient.

Code of Engineering Ethics

For many years our profession struggled along without having an established code of ethics—much to its detriment. Various technical societies made half-hearted attempts to establish codes, but most of them were "to laugh." A code suitable to one society did not prove acceptable to some of the others, and the large societies could not agree on the matter; but soon after the organization of our academy, we took hold of the subject methodically and energetically, and by means of a small committee, representing the principal lines of engineering activity, succeeded in evolving a code, which, after some slight modifications that were made to suit the desires of certain of the larger organizations, was accepted universally as standard. With the exception of a few minor changes made of late years, it is the code under which we all are now operating, and by which we are strictly governed in our dealings with each other, with our clients, and with the public.

Distinctions

Up to the time that the United States entered the Great War, there was a popular prejudice in our country against decorations and titles, on the plea that they were undemocratic; the government itself going so far as to prohibit its paid employees from accepting any foreign order of knighthood or any similar distinction, except through a special act of Congress. No matter, though, how much quiet sneering was done by Americans about the acceptance of foreign decorations by private citizens, it was to be noticed that none of them were ever rejected when offered.

Owing to the fact that in 1917 some of the governments of the Allies offered distinguished-service decorations for gallant conduct to several American soldiers, and that permanently to refuse them permission to accept the honor would have been discourteous to our friends, Congress early in 1918 repealed the law which prohibited the paid employees of the government from accepting orders, medals and other decorations from foreign governments. The result was that by the end of the war the "decoration habit" had taken such a hold on the American people that ere long several orders of knighthood and merit were formally established by Congress. Fortunately, the distribution of these honors has been kept absolutely free from political control; and to-day American men of learning prize these decorations far more highly than they do any pecuniary

rewards that they receive in compensation for their professional services.

Minimum Charges for Professional Work

After years of effort on the part of the American Institute of Consulting Engineers, that society finally succeeded in having Congress pass a bill placing an inferior limit on the compensation for engineering services; and the profession ever since has been trying, with more or less success, to force its members to live up to the requirements. Our academy, while not actively engaged in this endeavor, gave the institute its moral support. The observance of this law has not only directly increased the compensation of the independent engineers but also indirectly has been the means of augmenting that of their salaried brethren; besides, it has raised the profession greatly in the estimation of the public.

Improvement of Technical Literature

Although the technical literature in America during the first two decades of this century was far superior to that of the preceding century, there was still considerable room for improvement. There were too many books on the market which either were merely compilations or were without *raison d'être.* Most of these were written by either professors of engineering who did not possess the necessary practical knowledge or by young practitioners, ambitious to make a name for themselves before they had earned their spurs.

By the appointment of a standing joint-committee of the Society for the Promotion of Engineering Education and our academy, and through an unrecorded understanding with the leading publishers of scientific books, no technical treatise will be published by these companies unless it receives the written approval of that committee. Moreover, in order to save authors' time, the committee stands ready to advise with would-be authors concerning any proposed treatise before actual work is begun on the preparation of the manuscript, or at any time subsequent thereto. The influence of this committee on the character of American technical literature has been marked. The quality has been improved, while the quantity has been lessened.

(To be Concluded)